REMARKS

Claims 3-58 are presently pending in the application. Claims 11-14 and 23-50 remain withdrawn from consideration.

Claims 1 and 2 have been canceled and the subject matter thereof incorporated into claims 3 and 4. Claims 3 and 4 have also been amended to recite that a flux is applied to the fuse element, which is supported in the specification at least in paragraph [0025]. Finally, claims 51-58 have been amended to more correctly depend from claims 3 and 4. No new matter has been added by these amendments, and entry is respectfully requested.

In the Office Action, the Examiner has objected to claims 3-10, 15-22, and 52-58 as being of improper dependent form for failing to limit the subject matter of the respective independent claims. Claims 1 and 2 have been canceled and claims 3 and 4 have been rewritten in independent form, as suggested by the Examiner. Accordingly, reconsideration and withdrawal of the objection are respectfully requested.

The Examiner has rejected claims 1 and 2 under 35 U.S.C. § 103(a) as being unpatentable over European Patent Application No. 1,084,790 of Parachuri. The Examiner has also again rejected claims 1-6 under 35 U.S.C. § 103(a) as being unpatentable over each of JP 63-266034 ("JP '034), JP 63-266035 ("JP '035"), and JP 63-270437 ("JP '437"), collectively "the primary references." Further, claims 7-10 and 51-58 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over any of the primary references in view of U.S. Patent No. 4,451,814 of Barry et al. ("Barry"), JP 11-306940 ("JP '940"), and U.S. Patent No. 5,982,268 of Kawanishi ("Kawanishi"), collectively "the secondary references" or over Parachuri in view of any of the primary references and further in view of the secondary references. Finally, claims 15-22 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over any of the primary references in view of the secondary references and U.S. Patent No. 4,251,718 of Cole ("Cole") or over Parachuri in view of any of the primary references in view of the secondary references and Cole. Applicant respectfully traverses these rejections and the arguments in support thereof for the reasons set forth previously, which Applicant relies upon in full, and for the additional reasons which follow, and respectfully requests reconsideration and withdrawal of the rejections.

Rejection Under § 103(a) Based on Parachuri

Regarding claims 1 and 2, the Examiner argues that Parachuri teaches an alloy having approximately 15 weight % Sn, 55 weight % Bi, and 30 weight % In, and argues that it would have been obvious to select the claimed alloy composition based on the composition of Parachuri. Applicant respectfully traverses this rejection as follows. Claims 1 and 2 have been canceled by this Amendment, rendering the rejection of these claims moot. Accordingly, reconsideration and withdrawal of the rejection based on Parachuri are respectfully requested.

Rejections of Claims 1-6 Under § 103(a) Based on JP '034, JP '035, and JP '437(Primary References)

The Examiner maintains that JP '034 teaches fuse compositions which overlap with the claimed compositions, allegedly teaching a fuse element consisting of a small amount of copper and balance one or more of Pb, Bi, In, Cd, Sb, and Sn. The Examiner argues that the fuse composition consisting of Cu, Sb, In, Sn, and Bi does not contain Pb or Cd as required. Therefore, the Examiner concludes that it would have been obvious to one skilled in the art to select the claimed alloy fuse composition from the disclosed ranges of JP '034 because JP '034 teaches the same utility (an alloy fuse composition) throughout the whole disclosed range. The Examiner also argues that the fuses of JP '034 are formed from alloys and would inherently be sensitive to temperature and thus qualify as alloy type thermal fuses.

The Examiner argues that JP '035 also teaches fuse compositions which overlap with the claimed compositions, allegedly teaching a fuse element consisting of a specified amount of Al, Au, or Ag and balance one or more of Pb, Bi, In, Cd, Sb, and Sn. The Examiner argues that the fuse composition consisting of Ag or Au, Sb, In, Sn, and Bi does not contain Pb or Cd as required. Therefore, the Examiner concludes that it would have been obvious to one skilled in the art to select the claimed alloy fuse composition from the disclosed ranges of JP '035 because JP '035 teaches the same utility (an alloy fuse composition) throughout the whole disclosed range. The Examiner also argues that the fuses of JP '035 are formed from alloys and would inherently be sensitive to temperature and thus qualify as alloy type thermal fuses.

Finally, the Examiner argues that JP '437 teaches fuse compositions which overlap with the claimed compositions, allegedly teaching a fuse element consisting of a specified amount of

Al and Cu and a balance of one or more of Pb, Bi, In, Cd, Sb, and Sn. The Examiner argues that the fuse composition consisting of Cu, Sb, In, Sn, and Bi does not contain Pb or Cd as required. Therefore, the Examiner concludes that it would have been obvious to one skilled in the art to select the claimed alloy fuse composition from the disclosed ranges of JP '437 because JP '437 teaches the same utility (an alloy fuse composition) throughout the whole disclosed range. The Examiner also argues that the fuses of JP '437 are formed from alloys and would inherently be sensitive to temperature and thus qualify as alloy type thermal fuses.

In response to Applicants' previous arguments that the primary references do not teach the alloy compositions of the present invention, the Examiner maintains that there are embodiments in each of these references which do not require the presence of Pb. Additionally, the Examiner takes the position that since the primary references disclose alloys having melting temperatures below 700°C, which allegedly overlap with the claimed melting points, the prior art alloys would be applicable as thermal fuses. Applicant respectfully traverses these rejections as follows.

As previously explained on the record, the fuses taught by all of the primary references are current fuses, which are <u>not</u> alloy thermal fuses as claimed. Thus, none of the primary references teaches or suggests an alloy thermal fuse which comprise a fuse element containing a specific alloy composition and a flux applied to the fuse element. Accordingly, none of the primary references teaches or suggests all of the claimed elements.

Applicant again respectfully traverses the Examiner's unsubstantiated conclusion that the prior art alloys would inherently function as alloy thermal fuses. Alloy type thermal fuses and current fuses (conductors for fuses) are completely different from each other in several aspects, such as flux. Specifically, in contrast with current fuses, alloy thermal fuses utilize a flux for their operation. As described in paragraph [0002] of the present application, when an electrical appliance, for example, generates heat by an abnormality, the flux is activated, leading to wettability with respect to the electrodes. As a result, the thermal flux is divided and spheroidized. The fuse element alloy thus melts when an abnormally high level of heat is generated in the electrical appliance, thereby opening an electric current. The amount of In in an alloy composition for a thermal fuse must be controlled so that In, which is highly reactive, will not react with the flux in the surface of the fuse element and form an In salt.

In contrast, current fuses (as taught by the primary references) function by instantaneously breaking a wire when an overload current that is greater than a rated current is applied. These fuses thus blow out the fuse element by self-heating (or Joule's heat) of the fuse element, and thus flux is not necessary. In fact, if there is a flux in such a fuse, it is carbonized, thereby decreasing the insulation characteristics of a case. A flux is thus not only unnecessary, but undesirable in a current fuse. Accordingly, none of the primary references teaches or suggest an alloy thermal fuse comprising a fuse element with a flux applied thereto as claimed.

For the Examiner's consideration, enclosed herewith is U.S. Patent No. 5,019,457, which has the same inventor (Masanobu Nishio) as each of the primary references. Like the primary references, the '457 patent teaches current fuses, and a careful review of the '457 patent clearly indicates that adding a flux to a fuse element is not taught or suggested.

Accordingly, the alloys of the primary references would <u>not</u> function as materials for thermal fuse elements and one skilled in the art would not select the prior art fuses for use as thermal fuses. Further, none of the primary references teaches or suggests an alloy thermal fuse comprising a fuse element with a flux applied to the fuse element as claimed. Accordingly, reconsideration and withdrawal of the § 103(a) rejections based on the primary references are respectfully requested.

<u>Rejections Under § 103(a) Based on Primary References in view of Barry, JP '940, and Kawanishi (Secondary References)</u>

Regarding claims 7-10 and 51-58, the Examiner acknowledges that the elements recited in these claims are not taught by the primary references. However, the Examiner maintains that it would have been obvious to modify the alloys or fuses taught by the primary references to incorporate these elements, which are allegedly taught by the secondary references. The Examiner argues that Barry teaches a thermal fuse having specific leads, as well as materials containing indium, tin, or bismuth, and concludes that it would have been obvious to modify the alloys of the primary references by connecting the fuse element between two lead wires to form the thermal fuse. The Examiner's arguments regarding JP '940 have been set forth previously on the record and need not be repeated. Essentially, the Examiner concludes that it would have

been obvious based on JP '940 to modify the primary references to apply a Sn or Ag film to the surface of the lead conductors to improve their bonding strength. Finally, the Examiner argues that Kawanishi teaches adding a flux to a thermal element for a thermal fuse in order to exert an activation action on the melted fuse element, and thus concludes that it would have been obvious to one skilled in the art to add a flux to a fuse element of the prior art to exert an activation action on a melted fuse. Applicant respectfully traverses these rejections as follows.

First, regarding claims 7-10, as previously explained, none of the primary references teaches or suggests all of the elements of independent claims 3 or 4, namely, an alloy type thermal fuse having a fuse element comprising a specific alloy composition and a flux applied to the alloy composition. Further, these elements are also not taught by the secondary references cited by the Examiner. For example, JP '940 relates to a thin metallic film which may be provided on the surface of lead wires and Barry teaches a non-resettable thermal fuse, but no flux at all. Accordingly, none of the secondary references cures the deficiencies with the primary references, and even the proposed combinations of references would not teach or suggest all of the claimed elements.

Regarding claims 51-58, the Examiner argues that it would have been obvious to modify the fuses of the primary references to add a flux to the fuse element, as taught by Kawanishi The Examiner is completely misunderstanding the difference between current fuses and thermal fuses. As previously explained, not only is flux not needed in current fuses, as taught by the primary references, but actually would render the resulting fuses unfit for their intended use. Upon self-heating, the flux would carbonize, thereby decreasing the insulation characteristics of the case. Accordingly, there would have been no motivation to modify the fuses of the primary references to <u>decrease</u> their effectiveness by including flux, as suggested by the Examiner. For these reasons, reconsideration and withdrawal of the § 103(a) rejections are respectfully requested.

<u>*Rejections Under § 103(a) Based on Parachuri in view of Primary References and further in view of Secondary Referencesi*</u>

Regarding claims 7-10 and 51-58, the Examiner acknowledges that even a combination of Parachuri in view of the primary references would not teach or suggest all of the claimed

elements, such as that the fuse elements would be connected with lead conductors, that at least a portion of each lead conductor would be covered with a Sn or Ag film, or that a flux is applied to the fuse element. However, the Examiner argues that these aspects are taught by the secondary references, described above, and thus concludes that it would have been obvious to have modified the inventions of Parachuri in view of the primary references to incorporate these aspects and thus arrive at the presently claimed invention. Applicant respectfully traverses these rejections as follows.

Parachuri does not teach alloy thermal fuses at all, but rather is directed to a solder composition comprising a specific Sn-Bi-In metal alloy powder, a tin-based powder, and an alloying additive. The Examiner acknowledges that Parachuri does not teach or suggest a material for a thermal fuse. Parachuri does not teach or suggest an alloy thermal fuse and thus does not teach an alloy fuse comprising a fuse element and a flux applied to the fuse element. Further, there would have been no motivation to combine Parachuri, directed to a solder composition, with any of the primary or secondary references, directed to fuses. Accordingly, no *prima facie* case of obviousness has been established, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under § 103(a) Based on Parachuri in View of Primary References, Secondary References and Cole or Based on Primary References, Secondary References, and Cole

Regarding claims 15-22, the Examiner acknowledges that none of Parachuri, the primary references, or the secondary references teaches that a heating element for fusing off a fuse element would be included in the thermal fuse. However, the Examiner argues that Cole teaches that a resistor is thermally coupled to a thermal fuse, thereby allowing a predetermined amount of heat to cause the thermal fuse to blow. Therefore, the Examiner concludes that argues that it would have been obvious to have modified the proposed combinations of Parachuri, primary, and secondary references by thermally coupling a resistor to a thermal fuse, as taught by Cole, in order to allow for a predetermined amount of heat to cause the thermal fuse to blow. Applicants respectfully traverse these rejections as follows.

As previously explained on the record, Parachuri teaches solder compositions, not fuses of any type, and there would have been no motivation to combine Parachuri with any of the cited

references which is directed to a fuse. Further, there would have been no motivation to combine Parachuri with Cole, which teaches heating circuits, and certainly no way to provide the resistor of Cole to the solder composition of Parachuri.

Further, as also previously explained on the record, the primary references teach current fuses, not thermal fuses. Accordingly, there would have been no motivation to add the resistor of Cole to the current fuses of the primary references in order to allow for a predetermined amount of heat to cause the thermal fuse to blow, and certainly no reasonable expectation of success, since such a motivation would not even have made sense logistically. Accordingly, no *prima facie* case of obviousness has been established, and reconsideration and withdrawal of the § 103(a) rejections are respectfully requested.

In view of the preceding Amendments and Remarks, it is respectfully submitted that the pending claims are patentably distinct from the prior art of record, and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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Enclosure: U.S. Patent No. 5,019,457

United States Patent [19]

Nishio

[11] **Patent Number: 5,019,457**

[45] **Date of Patent: May 28, 1991**

[54] **CONDUCTOR USED AS A FUSE**

[75] Inventor: **Masanobu Nishio, Osaka, Japan**

[73] Assignee: **Sumitomo Electric Industries, Ltd., Osaka, Japan**

[21] Appl. No.: **477,132**

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[51] **Int. Cl.**^{5} **C22C 11/00; H01B 1/02; H01H 85/06**

[52] **U.S. Cl.** **428/606; 420/566**

[58] **Field of Search** **420/566; 428/606**

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[57] **ABSTRACT**

A conductor for a fuse has a main composition of a Pb-Ag alloy containing silver of 0.5 to 20 wt. % and lead and unavoidable impurity for the rest. A conductor for a fuse in another example includes a Pb-Ag-Cu or-/and Te alloy obtained by adding copper or/and tellurium of 0.05 to 1 wt. %, respectively, to the above mentioned Pb-Ag alloy. Each of those conductors for fuses has a diameter in the range from 0.05 to 0.3 mm and it is used as a fuse contained in a capacitor of a tantalum chip for example. Those conductors for fuses have excellent pre-arcing time/current characteristics and good drawability.

4 Claims, No Drawings

CONDUCTOR USED AS A FUSE

This application is a continuation of application Ser. No. 07/281,838 filed Dec. 8, 1988 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a conductor used as fuse which functions to instantaneously open a related circuit when an overcurrent exceeding a rated current flows, and particularly to a conductor to be used as fuse which is incorporated in a semiconductor device such as an IC or a transistor, or in a circuit component such as a capacitor. The present fuse conductor functions to prevent burning of the device or the component by opening the circuit of the device or the component when an overcurrent flows therein or when it is overheated.

2. Background Information

Conventionally, a metal such as Pb or Zn, or a Pb-Sn alloy is normally used as a fuse as mentioned in "Metal Manual (fourth edition issued Dec. 20, 1982, p. 1007)" edited by the Japan Institute of Metals. The fuse conductor formed of such metal or alloy is melted by Joule heat caused by an overcurrent, thereby to open an electric circuit. If it is desired to accurately set a "fusing" current independently of an outside air temperature, a conductor for a fuse formed of a tungsten wire is sometimes used. A Wood's metal melting at a low temperature is utilized as a fuse of a type melting by overheat in a heating atmosphere.

However, if it is desired to use any of such fuse conductors to add a circuit breaker function to a semiconductor device or a circuit component, it is difficult to draw the conductor to a fine wire or an extra fine wire which can be used. Consequently, under such circumstances, another device having a circuit breaker function is incorporated in a circuit of an electronic apparatus including. If such a fuse conductor itself is directly used, it is used in the form of a plate or a thick wire provided with notches for example so that its cross-sectional area is decreased.

Although a fine wire or an extra fine wire of Al, an alloy of Al, Cu or an alloy of Cu may be used as a fuse conductor, such a fuse conductor is not readily melted by an overcurrent.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a conductor for use as a fuse having an excellent pre-arcing time/current characteristic and good drawability.

A conductor for a fuse according to the present invention contains silver of 0.5 to 20 wt.% and the balance being lead and any unavoidable impurity.

A conductor for use as a fuse according to an aspect of the invention contains silver of 0.5 to 20 wt.%, the balance being lead and at least one low melting point metal selected from the group including bismuth, indium, cadmium, antimony and tin, and any unavoidable impurity. The content of the low melting point metal is smaller than that of lead.

A conductor for use as a fuse according to another aspect of the invention contains silver of 0.5 to 20 wt.%, at least either copper or tellurium of 0.05 to 1 wt.%, and the balance being lead and any unavoidable impurity.

A conductor for use as a fuse according to a further aspect of the invention contains silver of 0.5 to 20 wt.%, at least either copper or tellurium of 0.05 to 1 wt.%, and the remainder being lead, at least one low melting point metal selected from the group including bismuth, indium, cadmium, antimony and tin, and any unavoidable impurity. The content of the low melting point metal is smaller than that of lead.

According to a preferred embodiment of the invention, a conductor for use as a fuse is a conductor wire having an inner diameter in the range from 0.05 to 0.3 mm. A conductor for a fuse according to the present invention is preferably used a fuse contained in a capacitor.

An alloy of lead and silver has an improved tensile strength compared to that of lead alone. The liquidus temperature of this alloy is not so high compared with the melting point of lead. However, if the content of silver becomes too large, the liquidus temperature of the alloy increases and the alloy is not suited for a conductor fuse. Therefore, it is necessary to limit the content of silver within a given range. In addition, it was found by the inventors of the present invention that this alloy has an excellent pre-arcing time/current characteristic. Therefore, it is desirable to use as a fuse conductor, a fine wire of an alloy of lead and silver utilizing those characteristics.

A very small amount of copper or tellurium is added to the conductor mainly composed of the lead-silver alloy in order to improve a tensile strength of the conductor, which is drawn to a fine wire.

Accordingly, a conductor for use as a fuse according to a further example of the present invention contains silver of 0.5 to 20 wt.%, at least either copper or tellurium of 0.05 to 1 wt.%, and the balance being lead and any unavoidable impurity. Further, a conductor for a fuse according to a further example of the present invention contains at least one of the above mentioned low melting point metals in the lead-silver-copper and/or tellurium alloy. The content of the low melting point metal or metals is smaller than that of lead.

If the content of silver is less than 0.5 wt.%, it contributes little to improving the tensile strength required for a fuse conductor. It is difficult to draw a fine wire of the above alloy containing silver of less than 0.5 wt.%. On the other hand, if the content of silver exceeds 20 wt.%, the temperature for generating an entire liquid phase in that composition becomes high and exceeds a melting point temperature suitable for a fuse conductor and, in addition, the alloy becomes expensive.

If the content of copper is less than 0.05 wt.%, it contributes little to improving the tensile strength. If the content of copper exceeds 1 wt.%, the temperature for generating an entire liquid phase in that composition becomes too high and exceeds a melting point temperature suitable for a fuse conductor.

The reason for limiting the content of tellurium within the range of 0.05 to 1.0 wt.% is that the content of less than 0.05 wt.% contributes little to improving the tensile strength as in the case of copper and that the content of more than 1.0 wt.% does not contribute much to improving of the tensile strength. Copper and tellurium in the above described respective ranges are added simultaneously so that the tensile strength can be further improved.

If one or more low melting point metals other than lead are contained in the alloy composition according to the present invention, and if the content of such low

melting point metals becomes larger than that of lead, the drawability will be reduced. The contents of the low melting point metals are preferably in the ranges indicated below so as to ensure a good drawability and an excellent pre-arcing time/current characteristic.

Bi: 0.01 to 20 wt.%
In: 0.01 to 30 wt.%
Cd: 0.01 to 20 wt.%
Sb: 0.01 to 15 wt.%
Sn: 0.01 to 40 wt.%

In addition, by changing the contents of those low melting point metals in the above indicated ranges, it becomes possible to control a melting point temperature of the fuse conductor according to the purposes for which it is used.

The reason for limiting the preferable range of the diameter of the fuse conductor to 0.05 to 0.3 mm (50 to 300 μm) is that a diameter of more than 0.3 mm causes an increase in the current value necessary for melting the fuse conductor and makes it difficult to make a compact circuit component such as a capacitor where the fuse conductor is incorporated into the component. A diameter of less than 0.05 mm makes it difficult to fabricate wires of such a diameter in an industrial production process. Even if a wire of less than 0.05 mm can be fabricated, it will be difficult to handle a fuse conductor having a diameter of the less than 0.05 mm in cases of incorporating the fuse in a circuit component such as a capacitor, for example.

As described above, a fuse conductor according to the present invention has an excellent pre-arcing time/-current characteristic and a good drawability. In addition, since it can be drawn to a fine wire or an extra fine wire, it can be effectively utilized in various fields where a high resistance value is required for the conductor and it needs to be a fine wire or an extra fine wire. Particularly, a fuse conductor according to the present invention is effectively utilized in cases, for example, where a fusing function is to be added to the proper functions of a semiconductor device (such as an IC or a transistor) or a circuit component (such as a capacitor). Particularly, a conductor for use as a fuse according to the present invention is effectively used in a tantalum chip capacitor which will burn out if circuit components are incorporated erroneously. In such a case, it is not required to provide a device having a circuit breaker function incorporated in an electronic circuit separately from a semiconductor device or a circuit component as in the prior art. Therefore, the number of components to be incorporated can be reduced and an electronic apparatus with high reliability can be manufactured.

The foregoing and other objects, features, aspects and advantages of the present invention will become

more apparent from the following detailed description of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

Alloys or pure metals having the compositions shown in Table 1 were cast each in a mold having a square cross section 20 mm by 20 mm using a melting cast method. Billets thus obtained were subjected to forging and drawing processes, whereby alloy wires or pure metal wires of various diameters as shown in Table 1 were formed.

A predetermined current was caused to flow in the so formed alloy wires or pure metal wires, so that the pre-arcing time/current characteristics thereof were examined. In this case, the pre-arcing time/current characteristics were evaluated based on minimum current values necessary for melting within one second. Accordingly, it is understood that the lower is the minimum current value necessary for melting, the better is the pre-arcing time/current characteristic. In this test for the pre-arcing time/current characteristics, each of the alloy wires or the pure metal wires was electrically connected in a given circuit with the distance between electrodes being 35 mm.

The alloy wires having the compositions of the examples No. 1 to 13 according to the present invention were easily drawn as wires having diameters of 50 to 300 μm and the minimum current values necessary for melting within one second in those examples were in the range from 0.3 to 2 A. For comparison, pre-arcing time/current characteristics of conventional examples using Al were examined in the same manner. In this examination, an Al wire having a diameter of 130 μm was melted within one second when a current of 4 A was caused to flow therethrough. From the above mentioned results, it is understood that the fuse conductors containing alloys of a low melting point metal and silver according to the present invention have much better pre-arcing time/current characteristics than the comparing examples.

In addition, as shown in Table 1, as for the alloy wires or the pure metal wires of the compositions of the examples No. 15 to 18, namely, the alloy wires or the pure lead wires with the contents of silver being more than or less than the limit values, and the alloy wires with the content of bismuth being more than the upper limit value of the preferred range, continuous wires of diameters of less than 300 μm could not be obtained or a large fusing current was required for melting within one second even if a continuous wire was obtained. Further, the diameter of the alloy wire of the conventional example No. 14 was larger than the upper limit value of the preferred range and a large circuit breaker current was required for melting within one second.

TABLE 1

		Composition (wt. %)							Diameter	Circuit Breaker
	No.	Ag	Pb	Bi	In	Cd	Sb	Sn	(μm)	Current (A)
Examples of the Invention	1	0.5	rest	—	—	—	—	—	300	2
	2	3	rest	—	—	—	—	—	100	0.8
	3	5	rest	—	—	—	—	—	100	0.7
	4	7	rest	—	—	—	—	—	127	0.9
	5	10	rest	—	—	—	—	—	150	1.2
	6	15	rest	—	—	—	—	—	70	0.4
	7	20	rest	—	—	—	—	—	50	0.3
	8	10	rest	5	—	—	—	—	100	0.7
	9	5	rest	—	10	—	—	—	150	1.5

TABLE 1-continued

	No.	Composition (wt. %) Ag	Pb	Bi	In	Cd	Sb	Sn	Diameter (μm)	Circuit Breaker Current (A)
	10	5	rest	—	—	—	—	35	150	1.7
	11	7	rest	—	—	18	—	—	127	1.0
	12	3	rest	—	—	—	2	—	127	1.1
	13	5	rest	5	—	—	—	5	100	1.1
Examples for Comparison	14	5	rest	—	—	—	—	—	500	10
	15	0.005	rest	—	—	—	—	—	difficult to draw	*
	16	60	rest	—	—	—	—	—	300	5
	17	0	whole	—	—	—	—	—	difficult to draw	*
	18	3	rest	60	—	—	—	—	difficult to draw	*

*Measurement could not be made because of difficulty in drawing.

Embodiment 2

The alloy of Pb-5 wt.% Ag having the composition of the example No. 3 shown in Table 1, which was obtained according to the Embodiment 1, was used and a wire was drawn to have a diameter 130 μm in the same manner as in the Embodiment 1. A capacitor having a circuit breaker function using the alloy wire thus obtained, was prepared. In this embodiment, the alloy wire having the diameter 130 μm used as a fuse conductor had the following characteristics: a tensile load of 58 g, an electric resistance value of 18 Ω/m, and a circuit breaker current (a minimum current necessary for melting within one second) of 3.5 A.

When a current five times larger than a rated current value was caused to flow in the capacitor containing the above described fuse conductor, only the conductor was blown and no damage was caused to the electric circuit.

Embodiment 3

Alloys or pure metals having the compositions shown in Table 2 were cast each in a mold having a square cross section 20 mm by 20 mm by using a melting cast method. The billets thus obtained were subjected to forging and drawing processes so that alloy wires or pure metal wires of various diameters as shown in Table 2 were formed.

A predetermined current was caused to flow in the alloy wires or pure metal wires thus prepared so that the pre-arcing time/current characteristics thereof were examined. The pre-arcing time/current characteristics were evaluated based on minimum current values required for melting within one second. Accordingly, it is understood that the lower the minimum current value required for melting, the better is the pre-arcing time/current characteristic. In this test for the pre-arcing time/current characteristics, each of the alloy wires or the pure metal wires was electrically connected in a predetermined circuit with the distance between electrodes being 35 mm.

The alloy wires having the compositions of the examples No. 19 to 31 according to the present invention were easily drawn to have diameters of 50 to 300 μm and the minimum current values required for melting within one second in those wires were in the range from 0.3 to 2 A. For comparison, pre-arcing time/current characteristics of Al wires as conventional examples were examined. An Al wire having a diameter of 130 μm was melted in one second when a current of 4 A was caused to flow therethrough. From the above results, it is understood that the fuse conductors containing the low melting point metals and the alloy of silver and copper and/or tellurium have much better pre-arcing time/current characteristics.

In addition, as shown in Table 2, continuous wires of diameters of less than 300 μm could not be obtained as for the alloy wires or pure metal wires having the compositions of the examples No. 33 to No. 36 for comparison, namely, the alloy wires having a silver content more than or less than the limit values, the pure metal wire of lead, and the alloy wires having the contents of bismuth exceeding the upper limit value in the preferred range. Further, the alloy wire of the example No. 32 for comparison had the diameter exceeding the upper limit value of the preferred range and a larger fusing current was required for melting within one second.

TABLE 2

	No.	Composition (wt. %) Ag	Cu	Te	Pb	Bi	In	Cd	Sb	Sn	Diameter (μm)	Tensile Strength (kg/mm^2)	Circuit Breaker Current (A)
Examples of the Invention	19	0.5	0.08	—	rest	—	—	—	—	—	300	2.5	2
	20	5	0.05	0.05	rest	—	—	—	—	—	100	5.7	0.8
	21	7	—	0.1	rest	—	—	—	—	—	100	4.2	0.7
	22	10	0.05	0.05	rest	—	—	—	—	—	127	5.8	0.9
	23	20	0.50	0.50	rest	—	—	—	—	—	100	6.7	0.7
	24	20	0.15	0.15	rest	—	—	—	—	—	50	6.5	0.3
	25	5	0.15	0.10	rest	—	—	—	—	—	100	4.6	0.8
	26	10	0.15	0.15	rest	5	—	—	—	—	150	4.2	1.2
	27	5	0.10	0.10	rest	—	—	—	—	5	127	3.8	1.0
	28	5	0.25	0.25	rest	—	10	—	—	—	127	4.3	1.4
	29	10	0.10	0.20	rest	—	—	18	—	—	127	5.0	1.0
	30	10	0.20	0.20	rest	—	—	—	2	—	100	5.5	0.7
	31	15	0.30	0.30	rest	1	—	—	2	—	100	5.0	0.7
Examples for Comparison	32	5	0.05	0.05	rest	—	—	—	—	—	500	3.6	10
	33	0.005	—	—	rest	—	—	—	—	—	difficult to draw	*	*
	34	30	2	2	rest	—	—	—	—	—	difficult	*	*

TABLE 2-continued

No.	Composition (wt. %) Ag	Cu	Te	Pb	Bi	In	Cd	Sb	Sn	Diameter (μm)	Tensile Strength (kg/mm²)	Circuit Breaker Current (A)
										to draw		
35	0	0	0	whole	—	—	—	—	—	difficult to draw	*	*
36	3	0.10	0.10	rest	60	—	—	—	—	difficult to draw	*	*

*Measurement could not be made because of difficulty in drawing.

Embodiment 4

An alloy of Pb-20 wt.% Ag-0.15 wt.% Cu-0.15 wt.% Cu-0.15 wt.% Te of the composition No. 24 shown in Table 2, obtained according to the Embodiment 1 was used and a wire was drawn to have a diameter of 100 μm in the same manner as in Embodiment 3. A capacitor having a circuit breaker function using the alloy wire thus obtained was prepared. The above mentioned alloy wire having the diameter of 100 μm was used as a fuse conductor having the following characteristics: a tensile strength of 48 g, an electric resistance value of 21 Ω/m, and a circuit breaker current, minimum current necessary for melting within one second, of 1.0 A.

When a current five times larger than the rated current value was made to flow in the capacitor having the above described fuse conductor, only the conductor was blown and no damage was caused to the other electric circuit.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

What is claimed is:

1. An integrated circuit component, comprising a fuse conductor wire having a diameter within the range of 0.05 to 0.3 mm, said fuse conductor wire being made of an alloy consisting of 3 to 20% by weight of silver the balance being lead and any unavoidable impurity, said alloy enabling drawing said fuse conductor wire down to said diameter range of 0.05 to 0.3 mm for assuring a circuit breaker current suitable for protecting said integrated circuit component.

2. An integrated circuit component, comprising a fuse conductor wire having a diameter within the range of 0.05 to 0.3 mm, said fuse conductor wire being made of an alloy consisting of 3 to 20% by weight of silver, the balance being lead and at least one low melting point metal selected from the group consisting of bismuth, indium, cadmium antimony, and tin, wherein a content of said low melting point metal is smaller than that of said lead, and any unavoidable impurity, said alloy enabling drawing said fuse conductor wire down to said diameter range of 0.05 to 0.3 mm for assuring a circuit breaker current suitable for protecting said integrated circuit component.

3. An integrated circuit component, comprising a fuse conductor wire having a diameter within the range of 0.05 to 0.3 mm, said fuse conductor wire being made of an alloy consisting of 3-to 20% by weight of silver forming a first alloy component, a second alloy component selected from the group consisting of copper and tellurium 0.05 to 1.0% by weight, the balance being lead and any unavoidable impurity, said alloy enabling drawing said fuse conductor wire down to said diameter range of 0.05 to 0.3 mm for assuring a circuit breaker current suitable for protecting said integrated circuit component.

4. An integrated circuit component, comprising a fuse conductor wire having a diameter within the range of 0.05 to 0.3 mm, said fuse conductor wire being made of an alloy consisting of 3 to 20% by weight of silver forming a first alloy component, a second alloy component selected from the group consisting of copper and tellurium 0.05 to 1.0% by weight, a third alloy component forming the balance being lead and at least one low melting point metal selected from the group consisting of bismuth, indium, cadmium, antimony, and tin, and any unavoidable impurity, wherein the content of said at least one low melting point metal is smaller than that of said lead, said alloy enabling drawing said fuse conductor wire down to said diameter range of 0.05 to 0.3 mm for assuring a circuit breaker current suitable for protecting said integrated circuit component.

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